become a watery mass inclosed by the skin, similar to the cucumber from which the bacteria were taken for inoculation. At the time of the experiments some boxes of young tomato plants were close at hand, and into the centre of one of these a decaying cucumber was placed. In six hours some of the stems of the tomato plants six inches in height had rotted off close to the ground, where the liquid from the decaying fruit had come in contact with the young plants. In ten hours all the plants in the vicinity of the decaying cucumber were destroyed. Drops of the virus placed in the leaf axil of other plants quickly induced decay and death of the parts.

The virus from a cucumber was also used upon potato vines in the same manner as upon the squashes, but both the extreme age of the plants and the dry weather may have been unfavorable, as the decay was slow and comparatively harmless. Healthy tubers, however, when inoculated with the cucumber bacteria rotted with that rapidity characteristic of the bacterial decay of the potato. In all cases the tuber became of a pasty softness, and gave off a most unpleasant odor. This decaying substance when taken back to fresh fruit of the cucumbers continued to produce rapid decay.

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## Interesting anatomical and physiological researches.

### The leaves of aquatic monocotyledons.

M. Camille Sauvageau has just brought to a conclusion his noteworthy memoir[1] on the leaves of some aquatic monocotyledons. To the physiologist this contribution to a little known department of botanical science is no less interesting than to the morphologist. The studies of the author have been principally upon the *Potamogetonaceæ* (see Ascherson's monograph in Engler and Prantl: *Die natürlichen Pflanzenfamilien)*, and for the forty-eight species examined he announces that the histological characters of the leaf alone will be sufficient for identification. He finds, moreover, in *Zoste-*

[1] Ann. Sci. Nat., Botanique, 7. 13, pp. 102–296; *Sur les feuilles de quelques monocotyledones aquatiques.*

*ra, Phyllospadix, Halodula* and *Potamogeton* that there is a remarkable water-pore at the apex of the leaf, formed by the disintegration of certain epidermal cells. This pore is in communication with the vascular system of the leaf and together with the ordinary stomata on the under surface facilitates the passage of a current of water through the whole organ. By means of immersing cut-off shoots of *Potamogeton*, etc., imbedded in the ends of bent thistle-tubes containing water and attached to a mercury pressure-guage, in jars of water, Sauvageau demonstrates experimentally the absorption of water by the leaves. He concludes that there are currents of water, comparable to the water-current of transpiration in land-plants, in the leaves of the *Potamogetonaceæ*, and that, when deprived of their roots, these plants may continue to live and prosper by absorbing water and salt-solutions through their leaves. Plasmolytic phenomena noted indicate that in these plants the absorption of water may take place over the whole surface of the leaf.

In general it may be said that these extremely able and careful investigations of Sauvageau go far to show that absorption of water is, in some cases, an "important normal function" of leaves. This has not yet been entirely clear, notwithstanding the well-known experiments of Mayer and Boussingault.—CONWAY MACMILLAN.

## Structure of living protoplasm.

Probably the recent article by M. Fayod[1] upon this subject is as startling and difficult to reconcile with preconceived and accepted notions, as any physiological memoir that has appeared since the early days of karyokinesis literature. M. Fayod announces that protoplasm is not an emulsion, as it has lately been characterized by Bütschli and Quinke, nor is it a zoögloea-like by-product enclosing bacterioid *zell-granula*, as the Hartigs have indicated, nor a "complicated mixture" as Berthold somewhat indefinitely calls it. It is, on the contrary, a highly intricate network of spirally twisted, corkscrew-like, hollow fibrillæ, each possessing a hyaline wall negative to all staining reagents and capable of great dilation by the liquids or emulsions within. The nucleus is a peculiar knot of *spirofibrillæ*. The cell-wall possesses exactly the

[1] Rev. générale de Botan., May, 1891; *Structure du protoplasma vivant.*

same organization as the protoplasm. It is protoplasmic fibrillæ impregnated with cellulose. Certain obscure physiological problems are luminously explained under this view, viz., cell-growth, geotropism, ascension of sap, irritability in general, heliotropism, budding, and movements, such as those of amœbæ, plasmodia, bacteria and the diatoms. The method of M. Fayod—leaving aside the detail—is to inject bits of tissue with indigo, very finely powdered and in suspension. The preparation is dehydrated with alcohol after the usual method, and is examined in clove-oil. In this way it is possible to inject the spirally-twisted protoplasmic fibrillæ and thus expose them for examination and study. In seed-coat cells of *Cuphea* for example, the spirofibrillæ are found to have exactly the structure of a capillitium-fiber from certain *Trichias*—a genus of *Mycetozoa*.

This distinctly original view of protoplasmic constitution will, of course, need verification. It seems certain that peculiar spirally-twisted elements may be demonstrated in protoplasm by any one who follows Fayod's method, which is not a tedious one. The writer obtained results with epidermal cells from young *Pelargonium* leaves.

With the space at command, it is not possible to discuss fully the ingenious explanations which, under his conception of protoplasm, M. Fayod offers for the various physiological phenomena which present themselves to his notice. To most readers of his paper, however, it is certain that no page will be more interesting than the one on geotropism. Very simple, physical and mechanical laws suffice for the explanation of this *crux* of plant-physiologists. By the weight of liquids in the spirofibrillæ, under the action of gravity, longitudinal tension, in the cell-lining, is decreased and cell-formation takes place more readily along the line perpendicular to the surface of the earth. And the more gross materials will collect in the lower portions of fibrillæ and in the lower fibrillæ, leaving the finer, ethereal, easily dialysable substances uppermost, thus tending to inflate upper parts of fibrillæ and upper fibrillæ. Under such conditions of the mechanism, together with the variation of environment, nutritive rhythm, and changes periodic and constant in metabolic processes and products, Fayod finds little difficulty in explaining very clearly both geotropism and negative geotropism (*zenotropism*, turning toward the zenith). He quotes effectively the experiments in aggregation of Drosera-protoplasm which have become classic, and notes the more recent results of Elfving and Wortmann who find that the protoplasmic layer is thicker on the *under* side of cells in a negatively geotropic (zenotropic) organ.

It is impossible to dismiss so carefully prepared and important a paper as this of Fayod with a shrug of the shoulders, as has been done, the author observes, with his earlier notes on the matter. Especially in view of the recent advances in karyokinesis study, as indicated in the researches of Watase, Guignard, Carnoy, Zacharias, Pfitzer, Strasburger and others, it is evident the older emulsion-theory of protoplasm is beset with grave difficulties. It is probable that even so admirable a work as Berthold's *Studien über Protoplasmamechanik* does not say the last word upon its subject-matter. Fayod's paper is an original and valuable contribution to the most fundamental question of both plant and animal physiology.—CONWAY MACMILLAN.

## The relations of the phloem.

Within a few years our knowledge of the phloem region of the fibro-vascular bundles has been greatly extended. Not to go so far back as 1885, in which year appeared Hérail's Étude de la tige des Dicotylédons[1] in which the phloem received extensive consideration, we have last year Lamounette's extensive researches into the origin of the internal liber of the so-called "bicollateral" bundles.[2] Lamounette rejects the term "bicollateral" as did Herail, who considered it applicable only to the Cucurbitaceæ. In this terminology the internal phloem was looked upon as coordinate with the external phloem; whereas according to Lamounette (whose researches agree generally with those of Hérail where they touch common ground) the internal phloem is not developed from the procambium which produces the bundle, but arises from the pith parenchyma. It is not always easy to distinguish these two tissues, though in most cases this is easy because the internal phloem arises later than the xylem, so that the first formed spiral and annular vessels come to indicate the internal limits of the procambium before the internal phloem

[1] Annales d. Sci. Nat. Bot. VII. ii. 267.

[2] Annales d. Sci. Nat. Bot. VII. xi. p. 193–278.

begins to develop. In the Cucurbitaceæ, however, the differentiation takes place at the same time, but even in this case Lamounette will not allow the applicability of the term "bicollateral." Every gradation in time of appearance is found between the Cucurbitaceæ and the Basellaceæ in which the appearance of the internal phloem is very late.

Lamounette investigated the hypocotyl, stem and cotyledons of a large number of plants by the aid of serial sections cut by the collodion method.

At the beginning of this year Leonhard published his researches into the anatomy of the Apocynaceæ[1] which show that the internal phloem occurs throughout this order, with possibly one exception.

In the August number of the Annals of Botany Scott and Brebner have an extended account of their studies as to the relation between the stem and root-structure in plants with bicollateral bundles and the special modifications of the stem-structure in plants which belong to this category. They adhere to the term bicollateral as a matter of convenience without expressing any opinion as to the order of development, and cite the term "vascular bundle," as a convenient expression not now generally representing a well-defined unit, but applied to vascular tissues even when the limits of the individual bundles cannot be traced. "So long as an internal phloem strand has the same longitudinal course as the neighboring bundles of the leaf-trace there is no serious objection to regarding them as parts of the same formation."

"Bicollaterality is a character widely prevalent among the most highly organized dicotyledonous families [18 are known] and of great systematic value. It may fairly be maintained that these orders represent in certain directions the most advanced types of dicotyledonous structure.

"The physiological importance of bicollaterality cannot be fully estimated until the general question of the functions of the phloem has been finally determined, but it is undoubtedly great. The sheltering of a portion, often the larger portion, of the delicate phloem within the woody cylinder is an obvious advantage, as is also the fuller utilization of the pith-area and the consequent concentration of the tissues generally. It is probable also that the pith-cells themselves may be able to discharge both storing and conducting functions more effi-

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[1] Botanisches Centralblatt, xlv. p. 1.

ciently when brought into direct relation with the phloem and its proteid contents.

"In concluding we wish to point out the bearing of our subject on a theory which has recently been put forward as to the function of the phloem in general. In opposition to the prevailing view that the phloem is primarily a conducting tissue for the nitrogenous and especially for the proteid food-substances of the plant, Prof. Frank and Dr. Blass maintain that the phloem is essentially a store tissue for the benefit of the wood. (See this journal xv. 346.)

"We purposely avoid criticising Dr. Blass' arguments. . . . We willingly admit that in all plants with cambial growth, the supply of food materials for such growth must be an important function of the phloem. . . . But we wish to point out that the anatomical relations of the phloem are often quite inconsistent with the supposition that its principal or exclusive function is connected with the formation of wood.

"In all the numerous plants which have bicollateral bundles or an analogous arrangement of tissues, a great part of the phloem, often the greater part, and sometimes nearly the whole, is placed in that region of the stem where no formation of wood is going on, in a position as remote as possible from the wood-producing cambium, for the rare exceptions in which internal wood is formed may here be left out of consideration. Yet this internal phloem is absolutely typical in structure and contents. . . .

"So too with the phloem islands. In plants like Strychnos, these are no sooner formed than they become imbedded in dense wood, and are cut off from all direct communication with the cambium. It would be easy to cite other examples, as the stems of the Chenopodiaceæ and many other allied orders, in which almost all of the phloem is deeply imbedded in the fully-formed wood, or the monocotyledons generally, where the closed bundles retain a typical and active phloem for months and years after all formation of wood has been completed.

"In the light of facts such as these, we cannot but think that the view of Prof. Frank and Dr. Blass depends on too one-sided a consideration of typical dicotyledonous anatomy. . . . Our results as to the continuity of the various phloem-systems in root and stem tend to give further anatomical support to the theory of the conducting functions of this tissue, a theory which, we need hardly point out, is fully consistent with the view of Prof. Sachs, that the phloem may also be the seat of proteid-formation."—R.

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## BRIEFER ARTICLES.

**Pentstemon Haydeni**, n. sp.—Of the *Genuini* group: a foot or two high, glabrous, the stems decumbent, simple or branching, very leafy: cauline leaves, linear-lanceolate to linear, entire, 3 to 5 inches long by 1 to 3 lines broad, sessile and clasping: inflorescence a compactly crowded thyrse, the floral bracts from ovate-lanceolate and long-acuminate to ovate and acute, nearly equaling or the lower much exceeding the flowers; peduncles none or short: calyx-lobes acuminate, 3 to 5 lines long: corolla an inch long or more, the throat broadly dilated and the limb nearly equally lobed: sterile filament, bearded near the summit: capsule equaling the calyx.

This plant was first collected by Dr. F. V. Hayden, in the Laramie mountains of Wyoming, during some one of his early surveys, without flowers or fruit, and was referred by Dr. Gray to *P. acuminatus* as a form with linear cauline leaves. It was rediscovered during the past season, in flower and fruit, by Mr. H. L. Webber, of the Shaw School of Botany, on the Dismal River in Thomas county, Nebraska, about a hundred miles west of the 100th meridian. It has nearly the habit of the more conspicuously cordate-bracted forms of *P. acuminatus*, but with an extreme of discrepancy between the cauline leaves and floral bracts. The flowers are much larger and the throat of the corolla more dilated.—SERENO WATSON, *Cambridge, Mass.*

**A remarkable orange tree.**—There is in the herbarium of Brown University a specimen which is something of a curiosity. It was sent us last spring by Mr. Rowland Hazard, one of our trustees, from Santa Barbara, Cal. I quote from his letter of transmission.

"It is an orange tree which for years has lived and borne fruit without bark for a space of over seven inches entirely round the tree. I first saw this tree in February, 1885. It had been injured by a fire about three years before. When I saw it first it had a number of ripe oranges on it and in March it bloomed and bore fruit in the fall. The trunk was in substantially the same condition as you now see it. There was a space just above the ground where there was no bark and the sap-wood had rotted away, leaving only the heart-wood as the